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SUMMARY OF 1939 BLACK HILLS BEETLE STUDIES

COLORADO AND SOUTHERN WYOMING

By

Donald De Leon

Forest Insect Laboratory,
Fort Collins, Colorado,
February 26, 1940

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INTRODUCTION

The report of last year* summarized the results of all the work that had been done on the Black Hills beetle (Dendroctonus ponderosae Hopk.) by this station since its establishment in 1935. The present report, consequently, merely brings together the data secured on this insect the past season in the ponderosa pine stands of the North St. Vrain Canyon, near Estes Park, Colorado and in the lodgepole pine-limber pine stands of the Cold Spring area near Little Medicine, Wyoming. Work in this latter timber type had previously been carried out on Elk Mountain, Wyoming, but last summer it was transferred to Cold Spring because of easier access to infested trees and better camping conditions. The elevation at Cold Spring ranges from about 8500 to 9500 feet.

Wayne L. Howe and Robert T. Stevenson assisted the writer most of the summer and Calvin L. Massey worked on the project the latter part of August and the first part of September. Dwight A. Hester assisted in a large amount of the office work.

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*The biology of the Black Hills beetle....: Summary of Studies in Colorado and Wyoming 1935-1938, by Donald De Leon. Fort Collins, Colo. May 13, 1939.

LIFE HISTORY AND HABITS

Method of Study

Tree cages were erected in July to secure records of the time and amount of Black Hills beetle emergence, as had been done the four previous seasons. The tree cages used those seasons were flat cages, covering two square feet of bark, tacked to infested trees (Fig. 1). Considerable difficulty was had in keeping these cages tight as ants were constantly getting into some of them and no doubt carrying off specimens. In addition, a large amount of work was expended to secure a relatively small sample. In an effort to eliminate these difficulties a cylinder cage was tried. A section of an infested tree was cut out, the ends waxed to prevent excessive evaporation, suspended from a cross arm, and then caged (Fig. 2.). For Black Hills beetle emergence the cylinder-type cage seemed to be as suitable as the flat-type cage. Black Hills beetle emergence per square foot was practically the same in limber and lodgepole pine for the two types of cages and for ponderosa pine it was considerably greater in the cylinder cages (Tables Ia, IIa, IIIa, IVa). This was apparently caused by the chance selection of trees with poor brood. Table I shows the emergence in 1939 per square foot for the two cage-types.

Table I. Total Black Hills beetle brood emerging per square foot into the two types of cages for the three host trees.

Type of Cage	Host Tree: Lodgepole Pine: Emergence per sq. ft.	Lodgepole Pine: Basis in sq. ft.	Limber Pine: Emergence per sq. ft.	Limber Pine: Basis in sq. ft.	Ponderosa Pine: Emergence per sq. ft.	Ponderosa Pine: Basis in sq. ft.
Flat	30.6	14	82.2	8	8.0	6
Cylinder	25.2	29	83.2	105	30.2	58

For records of associated insects the cylinder cages seemed to be more suitable than the flat type cages. Very few ants were able to get into the cages and the number of different species of "associated" insects was reduced by nearly a third. In the collections of the previous years about 300 different species were collected from the flat-type tree cage, whereas last year only about 100 different species were secured from the new cages. Except for a few chalcids such as Copidosoma these insects probably emerged from the logs.

1939 Emergence

Period of Emergence. Peak emergence of the Black Hills beetle in 1939 was somewhat earlier from limber and lodgepole pine than it was the year before. In ponderosa pine it was about two weeks earlier than the previous year (Chart I). No explanation can be given at present for this earlier emergence. It was thought at first that it may have been caused by a more rapid drying out of the cut logs, but inspection of the total emergence records by

dates for the two types of cages indicates that the type of cage used had nothing to do with the time of emergence. Dates by which 90 percent of all the brood had emerged are shown in table II. This date is of some importance as it indicates how soon in the fall the extensive surveys can be started.

Table II. Approximate date by which 90 percent emergence of the Black Hills beetle occurred.

	Host Tree		
	Lodgepole Pine Elev. 9000'	Limber Pine Elev. 9000'	Ponderosa Pine Elev. 8000'
1935	August 26	August 30	--
1936	August 21	August 13	--
1937	August 26	August 20	August 29
1938	--	August 12*	September 2
1939	August 16	August 15	August 13

*8000'

The table shows that in general the emergence in 1939 from the three host trees was earlier than any preceding year for which records are available and that the emergence from ponderosa pine was a good two weeks earlier than in 1937 or 1938.

Tables Ia to VIIa inclusive in the appendix summarize the emergence records of the past season by host tree, cages, and date of collection.

Emergence per unit area.--Emergence per square foot according to the records secured from the tree cages was, on the whole, little changed over previous years. The indication is that it was slightly greater than the square-foot-emergence last year. The samples taken are such a small part of the total area of infested bark that these figures can be very inaccurate, but they are the only ones we have had to go by. Table III shows the cage emergence per square foot for the past five years.

Table III. New adult emergence per square foot.

Year of Emergence	Lodgepole Pine		Limber Pine		Ponderosa Pine	
	Average Emerging	Basis--sq. ft. caged	Average Emerging	Basis--sq. ft. caged	Average Emerging	Basis--sq. ft. caged
1935	18.2	32	164.5*	28	--	
1936	51.9	40	89.1	32		
1937	19.7	40	97.1	60	28	80
1938	--	--	66.9	12	21.5	40
1939	27.1	43	83.2	113	27.5	66

*This figure would be 174 if second year emergence were included.

Sex ratio of emerging beetles.--For the past two years all the Black Hills beetles emerging from tree cages, or in some cases a sample of 50 if the total emerging into one cage on any one collection day was greater than 50, were tallied according to sex. Since the amount of food supply, for some animals at least, influences the sex ratio of the progeny it was thought that a change

in the vitality of the infestation would perhaps be reflected by a change in the sex ratio. Table IV shows the sex ratio of the beetles emerging from the three host trees the past two years.

Table IV. Sex ratio of emerging new adult Black Hills beetles

Year of Emergence	Host Tree		
	Lodgepole Pine	Limber Pine	Ponderosa Pine
1938	1:1.46*	1:1.22**	1:1.58*
1939	1:1.29	1:1.17	1:1.60

*Chi square highly significant
**Chi square significant

Time did not permit working out statistically the significance of the sex ratio difference for the 1939 emergence.

Since the drop in the infestation this year has apparently been caused by beetle mortality during the flight period (Trend of Infestation, p. 8), it is felt that the use or lack of use of the sex ratio figures can not yet be demonstrated. Sex ratio figures will probably have to be secured for the emerging beetles for the next four or five years at least before anything definite can be stated concerning their value.

Size of emerging beetles.--The size of a given species of insect can usually be correlated with the availability of its food and with the developmental conditions. If these conditions are unfavorable for the growing larvae they should affect the quality of the emerging population; i.e., being less vigorous than insects developing under favorable conditions they would have less

chance of surviving, and those surviving would be expected to reproduce fewer progeny. If this were true of the Black Hills beetle one might expect to find the beetles of a declining infestation significantly smaller than those in an increasing infestation. In an attempt to see whether this was true a given number of emerging beetles have been measured for the past two years. The mean of these measurements is given in table V.

Table V. Mean size in millimeters of each sex reared from the three principal host trees.

Year of Emergence	Host Tree: Lodgepole Pine Male	Lodgepole Pine Female	Limber Pine Male	Limber Pine Female	Ponderosa Pine Male	Ponderosa Pine Female
1937*					5.7	6.3
1938*	4.7(1)	5.0(2)	5.2	5.7	5.6	6.0
1939**	5.21	5.71	5.44	5.88	5.6	6.2

*Based on 100 specimens of each sex except as noted.

**Based on 50 specimens of each sex.

(1) Based on 43 specimens from trees attacked in 1936.

(2) Based on 46 specimens from trees attacked in 1936.

It would appear from the above measurements that developmental conditions were not unfavorable for beetle development this past season.

The data for 1939 again indicate that the beetles emerging from lodgepole pine are smaller than those emerging from limber pine. Measurements were made of 50 beetles each attacking limber

and lodgepole pine to see whether by these measurements one could determine a host preference. According to Hopkins' host selection principle beetles emerging from one species of host tree prefer to attack the same species of host tree. If this were true one would expect the beetles attacking lodgepole pine and limber pine to have approximately the same mean size as those emerging from lodgepole pine and limber pine respectively. Not enough beetles were measured to determine whether or not such selection occurred but it would seem that, if time permitted, the measurement of several hundred attacking and emerging beetles from each host tree could be used to prove or disprove a host preference by this beetle for one of these two host trees.

Trend of Infestation

Judging from the emergence-per-square-foot records, there should have been practically no change in the number of trees hit in 1938 and those hit in 1939. The extensive surveys made in Region II by the Forest Service have shown, however, that there has been a great decrease in the amount of the 1939 infestation on all forests where these surveys were carried on. The two check plots on Elk Mountain also showed a decided drop in the number of infested trees in 1939 from the number hit in 1938.

As mentioned above the cage records indicate that the reduction in the number of trees infested in 1939 was caused not

by a reduction in the developing brood before it left its host tree but by a heavy mortality during the flight period. Further evidence that this may be what happened is a verbal statement by Hester that the new adult emergence from 1938 hit ponderosa pine, limber pine, and bristlecone pine on the Gunnison National Forest appeared to be exceptionally heavy. It was so heavy in fact that all the survey-crew members remarked about it, and because they found so few newly infested trees they were afraid that they were missing them in their survey strips or that the survey strips chanced to miss them. Similar observations were made in several areas on the Roosevelt National Forest. According to Hester, in only one unit, the North St. Vrain, was the estimate of the number of trees that would be infested in 1939 lower than what was actually found when the area was cruised out 100 percent during control work.

Attacks per unit area.--No data were collected this past season on the number of attacks per unit area for the 1939 infestation. It was planned to secure these data next summer from the 1939 infested logs hung last fall for parent beetle emergence records.

Eggs laid per gallery.--A few records were secured of the number of eggs laid by newly attacking beetles. These are given below.

Host tree	Galleries Measured	Mean Length	Eggs Laid			Average eggs laid per inch of gallery
			Average	Maximum	Minimum	
Lodgepole	4	13.5	59.7	77	42	4.4
Ponderosa	24	11.2	54.6	114	12	4.9

These measurements were made the end of August and it is possible that the full complement of eggs per gallery was not laid. It is believed, however, that later counts of the same galleries would not have shown an appreciable increase in the above averages. Eggs in galleries in limber pine were also counted, but these counts were made somewhat earlier in apparently later hit trees; since it seemed obvious that the galleries had not been completed, the counts for this host tree are not recorded. More counts should be made of the number of eggs laid per gallery for each host tree, as it seems quite possible that a change in the average number of eggs laid per gallery from year to year would reflect to some extent the vitality of the population and consequently the trend of an infestation.

Distribution of eggs in the gallery.--Table VI shows the average number of eggs per inch in the galleries measured. It indicates that the majority of eggs are laid between the second and twelfth inches of gallery.

Table VI. Egg disposition of the Black Hills beetle

	Averages--Eggs per inch		
	Ponderosa Pine	Limber Pine*	Lodgepole Pine
1st inch	1.0	--	.87
2nd "	5.2	5.5	1.6
3rd "	8.0	5.6	5.1
4th "	6.0	7.0	5.6
5th "	6.1	8.8	6.5
6th "	5.6	6.2	6.0
7th "	5.5	9.5	4.5
8th "	6.0	9.5	4.5
9th "	4.8	--	6.0
10th inch	5.1	--	7.5
11th "	4.5	--	6.8
12th "	3.6	--	3.0
13th "	4.9	--	5.5
14th "	3.9	--	3.5
15th "	1.6		3.5
16th "	3.0		1.5
17th "	3.0		--
18th "	.7		--
19th "	0		--
20th "	0		--
Basis (No. of galleries measured)	22	4	4

*Galleries not completed at time counts made.

Parent beetle emergence.--Figures on the amount of parent beetle emergence can not be given until counts are made next summer of the complete emergence from the 1939 infested log sections caged last fall. Some of these logs were caged each with a green uninfested log for the emerging parent beetles to reattack if they

cared to. Observations last fall indicated that there was quite a bit of parent beetle emergence and that reattacks in some of the green logs did occur.

A green log of limber pine into which emerged parent adult beetles were introduced was peeled during the winter. The data on this log are as follows:

Bark surface	4.1 sq. ft.
Parent adult beetles introduced	23
Total number of attacks	7
Average gallery length	12.4"
Maximum gallery length	22.5"
Minimum gallery length	7.0"
Average number of eggs laid per gallery	39.7
Maximum number of eggs laid	93.0
Minimum number of eggs laid	7.0

Although insufficient galleries were counted to secure the average number of eggs laid per gallery by the newly attacking beetle, as shown in the previous paragraph, the average secured

was about 57 per gallery. As the average number of eggs laid by the reattacking beetles was 40 per gallery, it would appear that the reattacking beetles lay about 31 percent fewer eggs. These figures are of course based on such meagre counts that they will no doubt be changed when more extensive records are obtained next summer from the logs caged last fall.

Pupal period.--A few records were secured of the pupal period of the beetle in ponderosa pine. The average pupal period of 18 specimens which were followed through from larva to new adults was 9.3 days; the minimum period was six days; the maximum 15 days.

Relation of number of attacks and gallery length to new adult emergence.--During the past two years 78 tree cages, each covering approximately 2 square feet of bark surface, were removed and the number of attacks and total gallery lengths within the caged areas counted. The total gallery lengths for each cage were plotted against the total number of emerging beetles in an attempt to find out whether there was a correlation between these two factors. No curve could be drawn for the points plotted. The same was true for the relation of attacks per square foot and amount of emerging beetles. Although these factors could not be correlated it is probable that if sufficient data were on hand some correlation could be shown. The variations in the records used do show, however, that there is a great fluctuation

in the amount of brood emerging that is not due primarily to the number of attacks per unit area nor to the total amount of gallery.

ASSOCIATED INSECTS

Fewer associated insects occurred per square foot of bark surface in the cages during the 1939 season than during the previous three years. This is shown in table VII.

Table VII. Emergence of associated insects.

Host Tree	Emerging insects per square foot	
	Black Hills beetle	All others*
Ponderosa Pine		
Year of Emergence		
1937	28	77
1938	21.5	70
1939	27.5	43
Limber Pine		
1937	97.1	96
1938	66.9	29
1939	83.2	24
Lodgepole Pine		
1939	27.1	26

*Ants and spiders were not recorded in 1939

The most common parasites and predators collected from the tree cages in 1939 are listed below by host trees. A few of the more abundant non-predacious insects are also listed.

Insect	Number of individual insects emerging					
	Ponderosa Pine: 65.6 sq. ft.		Limber Pine 113.5 sq.ft.		Lodgepole Pine 43.3 sq. ft.	
	Larvae	Adults	Larvae	Adults	Larvae	Adults
Enoclerus sphegeus		8		1		
E. lecontei	12	4	203	3	147	
Thanasimus undatulus				62		
Corticeus (substriatus group)	27	257	81	300	34	58
Platysoma punctigerum		35		7		
Plegaderus obesus		29	1	4		3
Epurea truncatella	10	32	74	11	32	33
Othnius occidentalis	176	39				
Corticotomus caviceps		28		5		11
Laemophloeus sp.		5	1	9	1	16
Temnochila virescens var.	12	8		1		
Aulonium longum	36	38	3	2	3	1
Staphylinids (larvae only listed)	253		32		13	
Coeloides dendroctoni				3		47
Lasconotus	29	23*	20		23	
Rhizophagus dimidiatus		12		9		27
Corticaria serrata		23		5		11
Orthotomicus ornatus		682				
Ips knausi		429				
Ips sp.				1415		
Cecidomyiids (striate larvae)	102		167		311	
Zabrachia sp.		2	57	34	55	

*Includes four species

SUMMARY

Emergence of the Black Hills beetle was in general somewhat earlier the past year than previous years. This was especially

true of the emergence from ponderosa pine, which was about two weeks earlier than usual.

Emergence per square foot based on tree cage collection records was slightly higher than the previous year. In spite of the apparent greater emergence per square foot there was a great drop in the number of newly infested trees throughout most of the central Rocky Mountain region. The mortality apparently occurred during the flight period.

Preliminary data collected last season indicated that the Black Hills beetle lays on the average 57 eggs per gallery; that about 5 eggs are laid per inch of total gallery, and that most of the eggs are laid between the second and 11th inches.

Parent beetle emergence again took place but final data on last year's emergence can not be given until bark counts are made next summer.

Fewer associated insects emerged per square foot than any previous year for which records are available.

Respectfully submitted,

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Associate Entomologist.

CC: Dr. Craighead (2)
Mr. Keen
Mr. Miller
Mr. Evenden

APPENDIX

Tabulation of Cage Collection Data

Table Ia. 1939 Black Hills beetle emergence from 1938 hit trees. Lodgepole Pine, Cold Spring, Wyoming.

Cage No.		Date of Collection: July 19	July 24	July 27	July 31	August 2	August 3	August 4	August 7	August 12	August 16	August 18
	M.		:0	1	3	3 (2)	3 (4)	9 (3)	3 (5)	10 (2)	2	
1A	F.			2	1	3	6	15	17	4	15	2
	M.	1	:2	3	1 (2)	5 (4)	6 (3)	9 (2)	2 (7)	15 (3)	7	
1B	F.	1		1	1	2	3	9	7	4	20	2
	M.	:0	:0	0	2	0	0	6 (1)	0	2 (3)	0	
10N	F.	1		0	1	0	0	0	8	0	3	0
	M.		(1)	0	3	0	0	8	0	1	1	
10S	F.			0	2	0	0	0	7	0	7	0
	M.	:0	:0	7 (1)	9	3	0	7 (1)	1	4	0	
11N	F.	1	1	6	8	4	0	17	1	1	0	
	M.	:1	:3	:19	0	:13	0	9 (2)	6 (1)	6	0	
11S	F.	0	4	19	0	8	0	17	17	14	0	
	M.	:0	:0	0				:2 (1)	0		0	
15E	F.	1	0	1					4	1	1	
	M.	:0	:0	1	1		2	2	5	8	4	
16N	F.	0	0	2	0		1	3	3	15	9	
	M.			1			0	1	5	10 (1)	1	
18W	F.			1				1	3	8	16	2
	M.		:2	2 (1)	:10 (2)	:16 (1)			:17 (4)	38 (6)		
21	F.		2	2	3	12			26	50		
	M.		:2 (4)	:10 (7)	:17 (4)	4 (1)	5 (2)	:41 (3)	3 (3)	31 (3)	0	
22	F.		3	12	19	8	8	39	7	38	2	
	M.	1	:1 :9	:44	:46	:44	:16	:92	:44	:125	:15	
	F.	1	3	13	46	37	41	34	118	74	180	18
Totals	():			5	9	8	8	9	12	21	18	
Total		2	4	27	99	91	93	59	222	139	323	33

Cage No.		Date of Collection: September 23	September 30	October 1	October 6	October 3,4, and 5	Totals: Males	Females	( )	Totals	Square feet caged	Emergence per square foot
	M.	(3)				(4)	35		23	125		
1A	F.	0						65			7.48	16.44
	M.					(1)	52		22			
1B	F.	0						50		124	8.46	14.66
	M.					1 (2)	11		6			
10N	F.	0				0		13		30	2	15.00
	M.						13		1			
10S	F.	0						16		30	2	15.00
	M.						31		2			
11N	F.	0						39		72	2	36.00
	M.				(1)		57		4			
11S	F.	0						79		140	2	70.50
	M.					1	3		1			
15E	F.	0				0		8		12	2	6.00
	M.				0	2 (1)	29		1			
16N	F.	3	1			3	1	47		77	2	38.50
	M.	1 (1)	6		1	2	28		2			
18W	F.	1	5		2	5		47		77	2	38.50
	M.	1 (1)	1 (2)		2 (1)	1	90		18			
21	F.	1	2		1	0		99		207	6.2	33.39
	M.	1	3		(1)		117		28			
22	F.	3	0					139		284	7.20	39.44
	M.	8	11		3	7	466					
	F.	13	12		6	6		602				
Totals	():	5	2		3	8			108			
Total		26	25		12	21				1176	43.34	27.13

Cages with N, S, E, or W after the cage number are flat cages--all others are cylinder cages.

M.--Male; F.--Female; ()--Sex unknown.

Emergence from 1933 Fir trees. Limber pine, Cold Spring, Wyoming.

Cage No.		Dates of Collection: July 19	July 24	July 27	July 31	August 2	August 3	August 4	August 7	August 12	August 16	August 18	August 23	August 30	September 1	September 6	October 3-4-5	Totals* Males	Totals* Females	Totals* ( )	Totals	Sq. Ft. Caged	Emergence per Sq. Ft.
2A	M.	0	0	3		4	25 (2)	12	26 (16)	3	10 (67)*	16	8		24	1	8 (2)	150		87			
	F.		1	0	1	3	16	12	27	9	40	23	8		19	2	8		169		406	8.16	49.75
3AA	M.	0	2 (2)	6 (1)	8	7	10 (4)	18 (2)	9 (1)		24 (56)	6	8 (1)	7 (2)		7 (2)	11 (2)	123		73			
	F.		1	0	2	9	16	12	41	23	26	8	1	2		4	6		151		347	7.95	43.65
3A	M.		(1)	6	11	18	21	17 (2)	4		30 (2)	3				(1)		110		5			
	F.				3	8	10	20	24	6	34	1							106		221	6.30	33.49
4A	M.	1	5	10	6	19 (18)	21 (326)	34			20 (488)	19	5 (2)	11	0	0		151		835			
	F.		0	3	9	11	34	29	46		30	21	6	5	0	4			198		1184	7.96	148.62
4B	M.	1 (1)	12	14	24 (2)	18 (47)	0	22 (1)			27 (310)	28	9		2 (1)			157		362			
	F.	0	1	11	17	40	32	0	26		33	24	7		2				193		712	7.42	95.96
4C	M.	0 (5)	0 (5)	1 (2)	3 (3)	5 (3)	14	18 (42)	17 (1)		17 (208)	8 (2)	(2)	1 (1)	0		(1)	84		275			
	F.		1	1	3	1	13	24	32	20	33	6			0	0			134		493	6.40	77.03
5A	M.			3 (1)	21 (1)	30	20 (29)	23 (77)	8		11 (80)	11 (4)	3 (1)	0 (2)	0	1	1	132		195			
	F.			4	16	30	30	27	14		39	3	2	2	0	9	2		178		505	7.48	67.51
6A	M.	2 (2)	1 (0)	7 (1)	12 (2)	23 (1)	22	28 (68)	7 (2)		19 (66)	18 (1)	7 (1)	6 (4)	0	8 (2)	1 (3)	161		153			
	F.		0	4	9	13	14	22	17		17	22	7	11	0	14	6		156		470	6.62	71.00
7A	M.	(3)	1 (1)	11 (3)	21 (1)	21 (15)	19 (100)	27 (1)	8 (1)		27 (104)	3 (1)	1	0	(5)	(1)	0	139		236			
	F.			3	13	25	29	31	33	9	25	2	1	3			0		174		549	6.08	73.85
8E	M.	1	2	8	8 (1)	1	0	14	12		10 (1)	0	1	0	0	0	0	57		2			
	F.		2	0	5	5	5	0	23	5	24	0		0	3	0	2	0	74		133	2	67.00
8W	M.	2 (1)	8	10	8	8	0	5 (1)	5		8	0	1 (1)	0	0	0 (1)	0	55		4			
	F.		1	4	15	6	7	0	18	12	7	0		0	0	0	1	0	71		130	2	65.00
9N	M.	(1)	0	4 (1)	3	7	0	20 (54)	17		25 (36)	6 (2)	1 (1)	5 (3)	0	1 (2)	0	89		100			
	F.			1	1	2	7	0	30	34	25	2	3	1	0		0		96		285	2	142.50
13A	M.			0	9	14	14	25 (37)	19		25	7 (1)	3	0	0	0	1 (1)	117		39			
	F.			0	4	10	14	25	20		25	9	2	0	3	0	1		113		269	6.67	40.33
13B	M.				2	7	9	20 (16)	13		18 (74)	2	3 (1)			1	0	75		91			
	F.					2	10	11	30	18	32	9				0	1		113		279	5.46	51.10
14A	M.		8	15 (1)	25 (5)	26 (2)	24 (2)	27 (70)	14 (1)		38 (195)	13 (1)	5 (1)					205		278			
	F.		0	12	17	34	31	23	26		24	14	4						192		675	6.8	95.15
17NE	M.	1	0	0	5	1	0	26 (16)	5 (2)		23 (74)					(2)		61		94			
	F.		0	0	1	1	1	0	24	15	24		1						68		221	2	110.00
19A	M.	1	(1)	2 (4)	9 ( )	4	18 (2)	21 (247)	25 (37)		24 (325)	13 (4)	10 (1)	9 (2)		8 (3)	4 (7)	148		635			
	F.		1	6	10	2	13	29	25		26	12	10	16		9	4		164		947	7.56	125.26
19B	M.	1 (1)	1 (1)	4	18	13 (1)	25 (1)	36 (254)	21 (39)		31 (468)	4	7 (3)	0		(1)	0	161		769			
	F.		1	5	14	12	37	61	29		30	5	2	3			1		202		1130	7.06	160.05
20A	M.	1 (1)	3	5	12 (2)	20 (34)	5	23 (157)	0		21 (78)	4 (2)	0	2 (1)		1 (0)	0	97		275			
	F.		1	0	1	5	32	11	30	0	29	6	1	0		0	0		116		488	7.61	63.99
Totals											418	161	72	41	26	28	26	2273					
	M.	1	9	28	102	203	260	250	395	253		523	167	54	46	24	45	29		2665			
	F.	0	9	12	90	159	299	326	528	354	2632	18	15	15	6	15	16			4508			
	( )		14	12	14	17	60	203	1386	85		3573	346	141	102	56	88	71			9446	113.53	83.2
Total		1	32	52	206	379	619	779	2309	692													

*A sample of 50 beetles was generally taken when emergence was greater than 50 beetles on any one collection day. Total also includes beetles too damaged to determine sex.

M.--Male; F.--Female; ( )--Sex unknown.

Table IIIa. 1939 Black Hills beetle emergence from 1938 hit trees. Ponderosa pine, North St. Vrain tree cages.

Cage No.		Date of Collection: June 26	July 3	July 8	July 13	July 17	July 19	July 21	July 24	July 25	July 27	July 29	July 31	August 2	August 4	August 8	August 10	August 12	August 14	August 16	August 18	August 22	August 24	August 28	November 31	November 1	Males
1-N	M.													1	0	2		1			1		2	2	1	0	11
	F.												1														
2-N	M.				1 (1)								1		2	2			1			0	2	3	2	0	1
	F.																										
2-S	M.																										
	F.																										
3-N	M.													1													
	F.							(6)	(2)								(1)		(1)	1 (2)					(1)	(1)	1
4-E	M.															1				1	3						
	F.																										
1A	M.		0	0	1	0	1	1	0	1	0	1 (1)		0 (2)	1	0	0	1 (1)			0	1			(2)	1 (1)	9
	F.		1	1	1	1	3	4	0	7	1	1		4	1	1	0	2			1	0					
2A	M.	0			0	2	0	2	1 (1)	0	2	1	3	9	3	10	0	5	5	0	4	1	1	0	2	0	0 (1)	45
	F.													7	2	4	1	3	4	0	1	3	0			0	
2B	M.	8*	1	1	1	0	1	0	0	0	4	0	4	2	11	(1)	8	10	29	1	8	0			(1)	1	92
	F.	4	0	7	8	7	1	3	2	0	0	0	1	2	10	31	2	10	30	1	1	6	2			0	
3A	M.	1	0											2	1	0	0	1	4	1	1	1			(2)	(1)	18
	F.	0	2			0	2	0	0	0	1	3		1	1	2	2	6	5	5	3	3					
3B	M.	2	2	0	4	5	1	1	0	0	3	0	0	(3)	0	0	0	0	1	1	1				0	1	22
	F.	1	1	0	2	4	1	0	2	0	3	2	4		2	1	1	0	3	0	0	1				0	
4A	M.													1 (1)	4	3	3	5	2	3	2	1				(2)	29
	F.													5	0	13	6	3	9	4	3	1					
4B	M.													2	0 (2)	5	0	3	3	0	0	1			0		23
	F.													7	7	5	3	3	17	3	4	1				1	
5A	M.													6 (2)	14	17	4 (2)	5	0	2	0	0 (1)			(1)		98
	F.													17	19	17	13	6	6	4	2	1				0 (1)	
5B	M.													13	22 (2)	8	2 (1)	4 (1)	3	2	1	(1)	(1)			1	173
	F.													15	20	20	3	6	2	1	1	1					
5C	M.													22	14	17 (3)	7	7	9	7 (5)	0	0 (1)		1	(1)	1 (1)	141
	F.													28	30	50	16	15	10	3	0	1		0		2	
	M.	11	3	1	12	17	11	55	45	26	56	44	16	58	61	73	24	42	56	18	18	5	3	3	1	4	663
	F.	6	3	8	20	31	15	79	80	35	98	75	24	89	94	145	47	55	87	24	21	15	3	4		2	
	( )			1	1		6	11	1	2	2	5		8	4	4	4	2	1	7		3	1		8	4	
Total		17	6	9	33	49	26	140	136	62	156	121	45	155	159	222	75	99	144	49	39	23	7	7	8	8	
																									11	16	

*June 29 collection

M.--Males; F.--Females; ( ) Sex undeterminable

**Approximate--Actual surface not yet measured.

Totals			Square feet of bark surface caged	Black Hills beetle emergence per square foot
Females	( )	Totals		
14		25	2**	12.50
	1			
		2	2**	1.50
1		1	2**	.50
	14			
5		20	2**	10.00
		0	2**	0
	7			
29		45	6.02	7.48
	2			
38		85	5.60	15.18
	2			
135		229	5.49	41.71
	3			
45		66	5.89	11.21
	3			
32		57	5.44	10.48
	10			
57		96	4.34	22.12
	2			
62		87	4.05	21.48
	7			
186		291	6.35	45.83
	10			
220		403	6.34	63.56
	18			
240		399	6.09	65.52
1064	79	1806	65.61	27.5

Table IVa. Emergence of the Black Hills beetle from caged trees. 1939 emergence from 1938 hit trees.

Limber Pine, Elev. 9000', Cold Spring, Wyo.					Lodgepole Pine, Elev. 9000', Cold Spring, Wyo.					Ponderosa Pine, Estes Park, Colo.				
Cage No.	Sq.ft. caged	Emergence Male	Female	Total	Cage No.	Sq.ft. caged	Emergence Male	Female	Total	Cage No.	Sq.ft. caged	Emergence Male	Female	Total
2A	8.16	150	169	406										
3AA	7.95	123	151	347	1A	7.48	35	65	123	1-N	2	11	14	25
3A	6.30	110	106	221	1B	8.46	52	50	124	2-N	2	1		3
4A	7.96	151	198	1184	10N	2	11	13	30	2-S	2		1	1
4B	7.42	157	193	712	10S	2	13	16	30	3-N	2	1	5	20
4C	6.40	84	134	493	11N	2	31	39	72	4-W	2	0	0	0
5A	7.48	132	178	505	11S	2	57	79	140	1A	6.2	9	29	45
6A	6.62	161	156	470	15E	2	3	8	12	2A	5.6	45	38	85
7A	6.08	139	174	549	16	2	29	47	77	2B	5.49	92	135	229
8E	2	57	74	133	18W	2	28	47	77	3A	5.89	18	45	66
8W	2	55	71	130	21	6.2	90	99	207	3B	5.44	22	32	57
9N	2	89	96	285	22	7.2	117	139	284	4A	4.34	29	57	96
13A	6.67	117	113	269						4B	4.05	23	62	87
13B	5.46	75	113	279						5A	6.35	98	186	291
14A	6.8	205	192	675						5B	6.34	173	220	403
17N	2	61	66	221						5C	6.09	141	240	399
19A	7.56	148	164	947										
19B	7.06	161	202	1130										
20A	7.61	97	116	488										
Total:	113.5	2273	2665	9446		43.3	466	602	1176		65.6	663	1064	1806
Emergence per sq. ft.				83.2					27.1					27.5
Sex ratio				1:1.17					1:1.29					1:1.60

Table Va. 1939 emergence of Black Hills Beetles from limber pine.
Cold Spring, Wyoming.
Trees hit in 1938. 113.5 sq. ft. bark caged.

Collection date	Total Emerging	Percent of Total	Total to date	Percent of total to date
July 19	1	.01	1	.01
24	32	.34	33	.35
27	52	.55	85	.90
31	206	2.18	291	3.08
Aug. 2	379	4.01	670	7.09
3	619	6.55	1289	13.64
4	779	8.25	2068	21.89
7	2309	24.44	4377	46.33
12	692	7.33	5069	53.66
16	3573	37.82	8642	91.48
18	346	3.66	8988	95.14
23	141	1.49	9129	96.63
30	102	1.08	9231	97.71
Sept. 1	56	.59	9287	98.31
6	88	.93	9375	99.25
Oct. 4	71	.75	9446	100.00

Table VIa. 1939 emergence of Black Hills beetles from lodgepole pine.
Cold Spring, Wyoming.
Trees hit in 1938. 43.3 square feet of bark caged

Collection Date	Total Emerging	Percent of Total	Total to Date	Percent of Total to Date
July 19	2	.17	2	.17
24	4	.34	6	.51
27	27	2.29	33	2.81
31	99	8.42	132	11.23
Aug. 2	91	7.74	223	18.96
3	93	7.90	316	26.87
4	59	4.02	375	31.89
7	222	18.88	597	50.76
12	139	11.82	736	62.58
16	323	27.47	1059	90.05
18	33	2.81	1092	92.85
23	26	2.22	1118	95.06
30	25	2.12	1143	97.19
Sept. 6	12	1.02	1155	98.21
Oct. 4	21	1.79	1176	100.00

Table VIIa. 1939 emergence of Black Hills beetle from ponderosa pine.
Estes Park, Colo.
Trees hit in 1938. 65.6 square feet bark caged.

Collection Date	Total Emerging	Percent of Total	Total to Date	Percent of Total to Date
June 26	17	.94	17	.94
July 3	6	.33	23	1.27
8	9	.49	32	1.76
13	33	1.82	65	3.58
17	49	2.71	114	6.29
19	26	1.44	140	7.75
21	140	7.75	280	15.48
24	136	7.73	416	23.21
25	62	3.43	478	26.64
27	156	8.64	634	35.28
29	121	6.69	755	41.97
31	45	2.49	800	44.46
Aug. 2	155	8.63	955	53.09
4	159	8.80	1114	61.68
8	222	12.29	1336	73.97
10	75	4.15	1411	78.12
12	99	5.48	1510	83.60
14	144	7.97	1654	91.58
16	49	2.71	1703	94.29
18	39	2.15	1742	96.45
22	23	1.27	1765	97.72
24	7	.39	1772	98.11
28	7	.39	1779	98.50
31	11	.61	1790	99.11
Nov. 1	16	.89	1806	100.00

Figure 1.--Tree cage for collection of emerging insects.

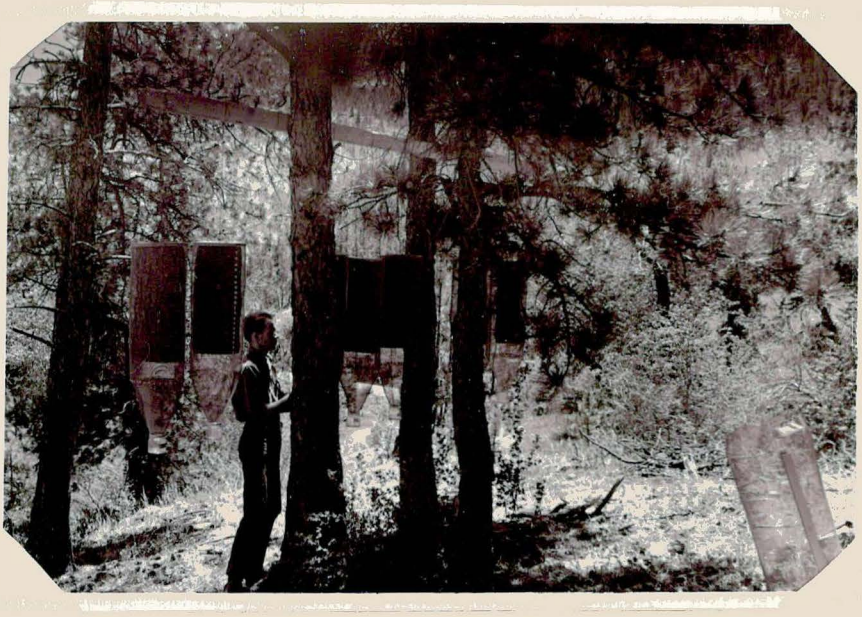

Figure 2.--Cylinder tree cage for collection of emerging beetles.

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